6.0 MITIGATION, MINIMIZATION AND AVOIDANCE MEASURES

The following describes actions and measures incorporated into the design of the Applicant's Preferred Alternative – Alternative 3 to avoid and/or minimize direct, indirect, and cumulative effects to the resources found within the Permit Area and the species that utilize them.

6.1 AVOIDANCE, MINIMIZATION AND INNOVATIVE DESIGN MEASURES

Earlier channel designs included a connecting channel, extending the ocean bar channel through New River Inlet and up to Cedar Bush Cut. This channel design was proposed for obtaining beach compatible material of a coarser grain size. However, the connecting channel was removed from the design in the early stages of project planning and development to avoid direct impacts to softbottom communities and potential indirect impacts to salt marsh, shellfish habitat and unknown submerged aquatic vegetative communities in the inlet complex.

Point of Intercept Design

The offshore borrow area and beach fill designs were also revised during the early stages of project planning to avoid impacts to nearshore hardbottom resources. Prior to April 2006, the material from the offshore borrow area was determined to have a mean grain size very close to the native material. Placement of the same mean grain size material could result in the material moving offshore during post-nourishment adjustments, which could potentially impact over 16 acres of nearshore hardbottom resources. During the April 12, 2006 PDT meeting, CPE-NC presented the point of intercept concept based on a relationship between the mean grain size of beach material and the equilibrium shape of a beach fill profile developed by Dr. Robert Dean of the University of Florida and reported in the Corps of Engineers Coastal Engineering Manual (USACE, 2002) (see Appendix A – Subpart 1, and Appendix B – Final Engineering Report). The equilibrium beach profile concept (perched beach design) involves designing steeper beach profiles with a higher retention rate of material in the upper portions of the beach profile by using material with a greater mean grain size than the native beach sediment.

Figure 16 illustrates the difference that the grain size of fill material has on the point in which the new profile intercepts the existing profile. The red line (Average Existing Profile (860+00 to 900+00) represents the current beach profile for the area between USACE baseline stations 860+00 and 900+00. Note that the nearshore edge of hardbottom habitat is located approximately 730 ft offshore of the USACE baseline (blue vertical line). The profile that would be established if material of equal grain size to that of the native beach (0.23 mm) were used is represented by the light blue profile (Equilibrated Beach Profile (Fill

= 0.23 mm)). The equilibrated beach profile shows that sand from the beach would migrate out and cover portions of the hardbottom habitat. The point of intercept for this material would be located approximately 1,075 ft offshore the USACE baseline. The profile that would be established if material of at least 0.33 mm (grain size of coarse fill in offshore borrow area) were used is represented by the yellow profile (Equilibrated Beach Profile (Fill = 0.33 mm)). The point of intercept for this material would be located approximately 330 ft from the USACE baseline, which is approximately 400 ft. landward of the edge of the hardbotom habitat. This engineering model will be utilized for those phases that have known hardbottom resources in the nearshore environment including Phases 1 through 4 (see Figures 5 thru 7 in Section 3).

Based on this design concept, CPE-NC evaluated in detail the availability of coarse material in the offshore borrow area and in the New River Inlet channel for creating intercepting profiles in the nearshore hardbottom areas. The offshore borrow area was divided into two sections, a finer grain size area (composite mean grain size of 0.21 mm) containing approximately 6.19 million cy of material, and a coarser grain size area (composite mean grain size of 0.33 mm) containing approximately 356,839 cy of material. In the case of the proposed ocean bar channel at New River Inlet, approximately 544,400 cy (with side slopes) of beach compatible sand with a mean grain size of 0.39 mm was identified. These two sources, the relatively coarse portion of the offshore borrow area and the sand to be removed from within the proposed ocean bar channel at New River Inlet are coarser than the native material of 0.23 mm and therefore will allow for the implementation of the point of intercept concept.

As a result, Alternatives 3 through 6, have been designed to include selective dredging and placement of coarse fill material to create a perched beach fill design along specific areas of the beach. Select fill areas located landward of hardbottom outcroppings, approximately 350 m (1,150 ft) offshore of the February-March 2002 mean high water line, include the perched beach design. Phase 1, under Alternative 3, which includes the shoreline between USACE baseline stations 1070+00 to 1160+00, will use coarse material from the dredging of the proposed ocean bar channel of New River Inlet to construct a 17 m (57 ft) berm width to avoid coverage of nearshore hardbottom. Phase 2 will involve placing coarse material from the offshore borrow area along the shoreline between USACE baseline stations 1020+00 to 1070+00. Similarly, a 14.6 m (48 ft) berm width has been designed for the fill area between USACE baseline stations 840+00 to 900+00 in the Central section, which will receive coarse material from maintenance dredging of the ocean bar channel at New River Inlet. The result of this design initiative involves a point-of-intercept (depth of closure) occurring approximately 244 m (800 ft) landward of the hardbottom edge, thereby avoiding direct impacts to nearshore hardbottom resources. Placement of the coarse material will extend approximately 300 m (1,000 ft) north and 150 m (500 ft) south of the shoreline adjacent to hardbottom to minimize the potential indirect effects from longshore movement of fill material.

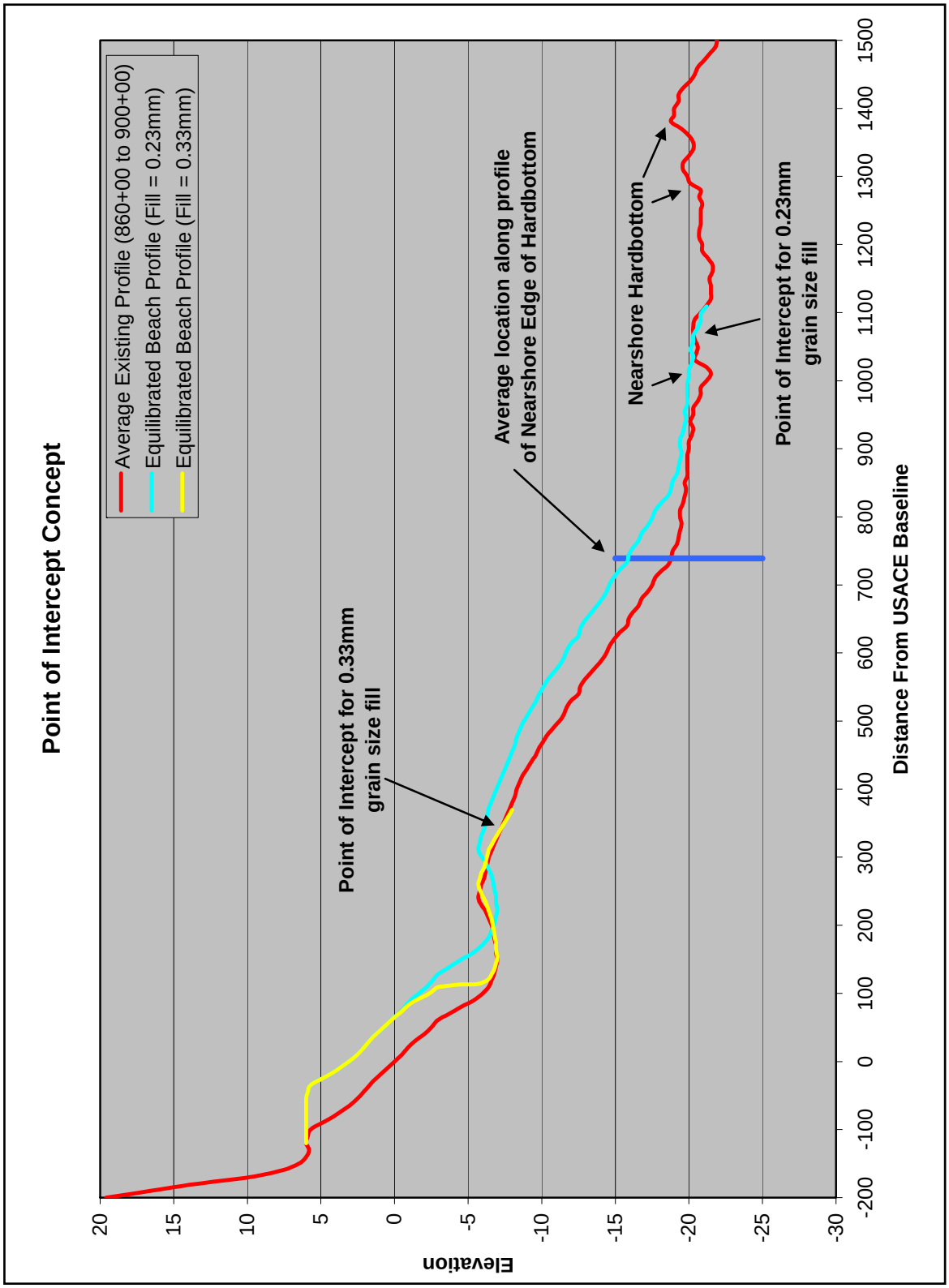

Figure 16. Graph depicting point of intercept concept.

6.1.1 Sediment Compatibility

Based on consultation with the USACE – Wilmington District and the USFWS, the Town has developed the proposed project with the highest degree of sediment compatibility. As noted below, the Sediment Criteria Rule, contained in the Technical Standards for Beach Fill Projects (15A NCAC 07H .0312), provides beneficial guidelines for both grain size and percent weigh of calcium carbonate. However, other important characteristics such as organic content, heavy mineral content, and color are not addressed. These aspects of the beach fill will be considered. The monitoring program for sediment as it is placed on the beach will provide a benefit to the beach invertebrate community and would also benefit sea turtle nest construction and incubation of the eggs.

The North Carolina Coastal Resources Commission adopted new State Sediment Criteria Rule Language (15A NCAC 07H .0312) for borrow material aimed at preventing the disposal of an inordinate amount of coarse material (primarily shell and shell hash) on the beach (NCDCM, 2008a) (see Section 5.16.7.1). The new rule limits the amount of material in the borrow area with a diameter equal to or greater than 4.76 mm and less than 76.00 mm (gravel) to no more than 5% above that which exists on the native beach. Also, the percent of the borrow material by weight between 4.76 mm and 2.0 mm (Granular) cannot exceed the native by more than 5%. In the case of North Topsail Beach, which has an average gravel content of 0.43% and an average granular content of 1.07 mm, the upper limit of gravel and granular that could be placed on the beach is 5.43% and 6.07%, respectively. The rule also limits the amount of silt (sediment size equal to or less than 0.0625 mm) to 5% above the native beach material. Based on a native silt average of 1.56% at North Topsail Beach, the allowable silt content of material to be placed on the beach is 6.56%. Finally, the State Sediment Criteria Rule Language limits calcium carbonate to no more than 15% above that of the native beach. Based on a native calcium carbonate percentage of 25.83%, the allowable calcium carbonate % of material to be placed on the beach would be limited to 40.83%. The new rule language has been adhered to during the planning and development of the North Topsail Beach Shoreline Protection Project, which reduces the potential for negative effects of beach nourishment (See Appendix C – Final Geotechnical Report).

As a result of sediment compliance efforts, compaction of fill material on the beach is less likely to occur due to the lower silt content or hardening of the beach due to high shell and/or carbonates. Compaction of fill could impact the ability of sea turtles to dig and nest along the nourished beach, resulting in an increase in false crawls. Also, macroinfauna indicative of a healthy benthic community depend upon variable particle sizes and available interstitial pore space in the substrate for aeration properties. Compaction of the fill material could impact resident macroinfaunal populations thereby affecting the migratory

and resident shorebirds, waterbirds, as well as the commercially and recreationally important fish that depend upon them.

Following construction of each phase of the proposed project, compaction of placed fill material will be inspected by the Town, the Engineer, or his duly authorized representative in coordination with the Division of Coastal Management and USACE. Compaction monitoring will begin after the material has been graded and dressed to the final slope and a period of time will be allowed for finer particles to be washed away and final settling of the material to occur prior to compaction monitoring. All compaction monitoring will be completed in time to allow for remedial actions to be completed prior to May 1 of each year. If the fill material appears to have a higher degree of compaction than that which is acceptable additional testing such as cone penetration testing will be considered. After subsequent testing, if it is determined that tilling is necessary to reduce compaction based on consultation with the appropriate agencies, the contractor will till the beach to a minimum depth of 36 inches throughout the constructed portion of the beach to loosen the compaction of the placed material. Beach tilling will only be performed as a result of an identified compaction problem based on agency consultation. Beach compaction monitoring and, if necessary, tilling would ensure that project impacts on sea turtle nesting are minimized.

Although the State rules do not make any reference to compatibility with regards to color, native and borrow area color values were recorded and compiled during field investigations. Native beach composite colors referenced to the Munsell Soil Color Chart (1994) were determined to be gray to grayish brown with a value of 5.4 for wet sand and light gray with a value of 7.0 for dry sand. Borrow area composite colors referenced to the Munsell Soil Color Chart (1994) were determined to be dark gray to olive gray with a value of 4.6 for wet sand and gray to light olive gray with a value of 6.3 for dry sand. This resemblance in color between native and fill material will minimize the risk of changing the natural incubation temperature of sea turtle nests in the nourished area. Although no published data appears to be available it is commonly observed that material placed on a beach undergoes bleaching within the first several months which results in a lighter color sand than what was documented to exist in the borrow area.

6.2 CONSTRUCTION PRACTICES

A hydraulic cutterhead is proposed for dredging in the offshore borrow area and in the realigned ocean bar channel at New River Inlet. A cutterhead dredge uses a rotating cutter assembly at the end of a ladder arm to excavate bottom material, which is then drawn into the suction arm and pumped to the shoreline. On the beach, pipelines will transport the sediment to the designated beach fill area. Bulldozers will be used to construct seaward shore parallel dikes to contain the material on the beach, and to shape the beach to the appropriate

construction cross-section template. During construction, the contractor will utilize surveying techniques for compliance with the designed berm width, height, and slope.

Compared to similar types of dredging methodologies, a cutterhead dredge creates minimal disturbance to the seafloor resulting in lower sedimentation and turbidity levels. Anchor (2003) conducted a literature review of suspended sediments from dredging activities. This report concluded that the use of a hydraulic dredge (i.e., cutter suction) limits the possibilities for resuspension of sediment to the point of extraction. Also, since the sediment is suctioned into the dredge head, the sediment cannot directly enter into the middle or upper water column.

No incidences of sea turtle takes from a hydraulic dredge have been identified during the research and development of this document. Therefore, the use and methods involved with this type of machinery reduces or eliminates the likelihood of an incidental take.

Visual surveys of escarpments will be made along the beach fill area immediately after completion of construction, and at three-month intervals for three years following completion of construction. After appropriate consultation with the NCDCM and USACE, escarpments in the newly placed beach fill that exceed 18 inches for greater than 100 ft shall be graded to match adjacent grades on the beach. Removal of any escarpments during the sea turtle hatching season (May 1 through November 15) shall be coordinated with the North Carolina Wildlife Resources Commission (NCWRC), USFWS, and the USACE – Wilmington District.

Additionally, construction practices will adhere to the 2003 Guidelines for Avoiding Impacts to the West Indian Manatee – Precautionary Measures for Construction Activities in North Carolina as described below.

6.2.1 Dredge Positioning

DREDGEPAK® or similar navigation and positioning software will be used by the contractor to accurately track the dredge location in relation to the hardbottom buffer protection zones. The software will provide real-time dredge positioning and digging functions to allow color display of dredge shape, physical feature data as found in background Computer Aided Design (CAD) charts and color contour matrix files from hydrographic data collection software described above on a leveroom Cathode Ray Tube (CRT) display. The software shall also provide a display of theoretical volume quantities removed during actual dredging operations.

Dredge anchors shall not be placed any further than 61 m (200 ft) from the edge of the borrow area. The dredge contractor will be required to verify the location

of the anchors with real time positioning each and every time the anchors are relocated.

6.2.2 Pipeline Observations

Four pipeline corridors have been selected for the placement of the submerged pipeline during dredging operations from the borrow area (Figure 17). The 60 m (200 ft) wide corridors were selected to avoid impacts to hardbottom resources identified from sidescan sonar surveys and diver groundtruthing surveys conducted off North Topsail Beach. All four corridors are positioned approximately 137 m (450 ft) or greater from the edge of hardbottom resources. In the event that future surveys or investigations indicate hardbottom resources in pipeline corridors, the corridor will be adjusted to avoid impacts to these resources to the greatest extent practical. In order to minimize adverse impact on wintering piping plover, the pipeline alignment was designed to also avoid potential piping plover wintering habitat. The alignment will be coordinated with, and approved by, the USACE. As-built positions of the pipeline will be recorded using GPS technology and included in the final construction observation report.

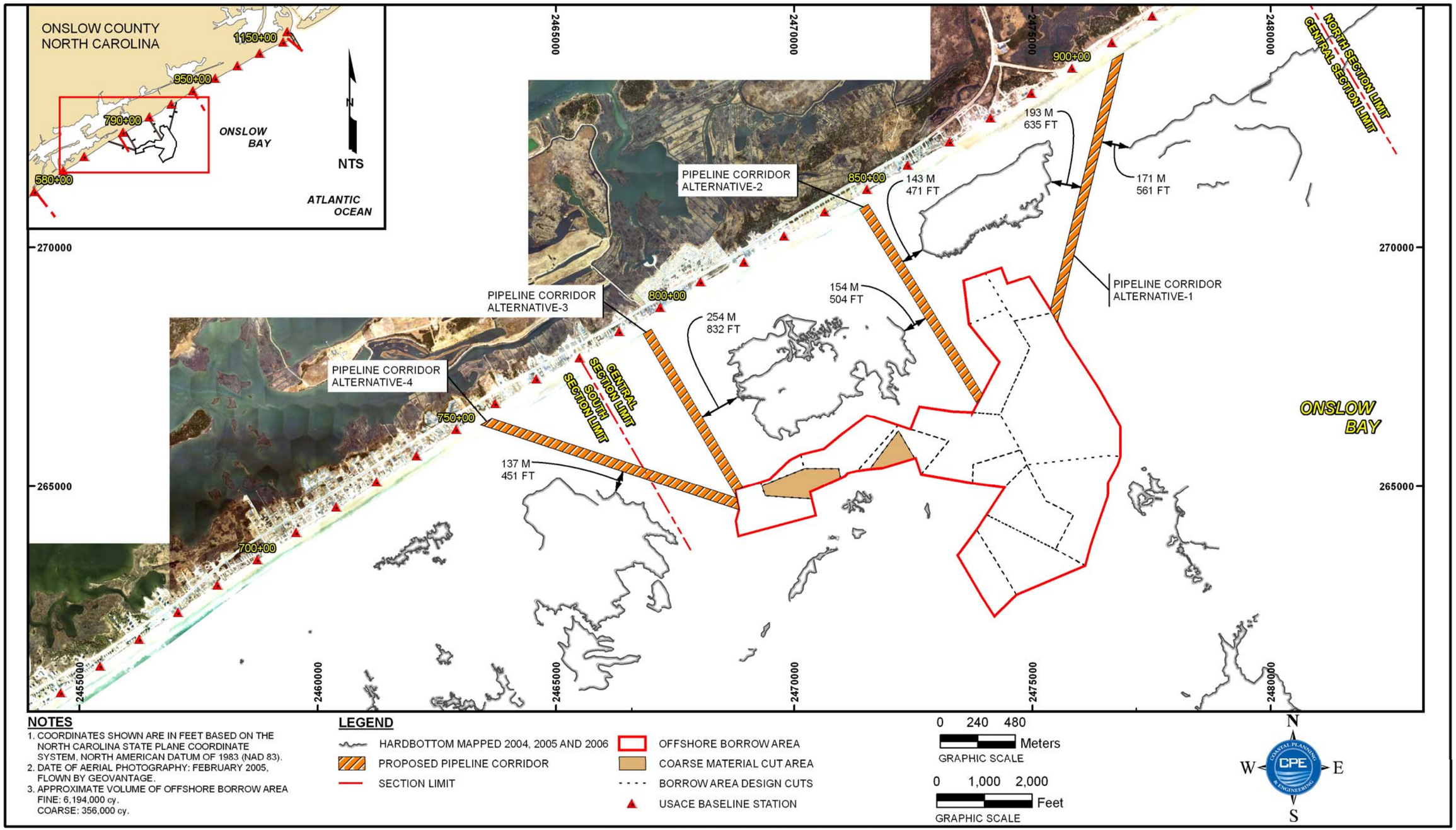

Figure 17. Pipeline Corridor Alternatives

In order to avoid adverse impacts associated with the transport of fill material to the disposal sites, the Town of North Topsail Beach will negotiate with the dredging contractor to monitor and assess the pipeline during each construction phase. This will serve to avoid leaking of sediment material from the pipeline couplings, other equipment, or other pipeline leaks that may result in sediment plumes, siltation and/or elevated turbidity levels. The Town of North Topsail Beach along with their Engineer will coordinate with the dredgers and have in place a mechanism to cease dredge and fill activities in the event that a substantial leak is detected (leaks resulting in turbidity that exceed state water quality standards or sedimentation). Operations may resume upon appropriate repair of affected couplings or other equipment.

6.2.3 Construction Observations

Several initiatives will be undertaken by the Town, the Engineer, or his duly authorized representative to monitor construction practices. Construction observation and contract administration will be periodically performed 7 days a week, approximately 12 hours a day during periods of active construction. Most observations will be during daylight hours; however, random nighttime observations may be conducted. The Town, the Engineer, or his duly authorized representative will provide onsite observation by an individual with training or experience in beach nourishment and construction observation and testing, and that is knowledgeable of the project design and permit conditions. The project manager, a coastal engineer, will coordinate with the field observer. Multiple daily observations of the pumpout location will be made by the Town, the Engineer, or his duly authorized representative for QA/QC of the material being placed on the beach. The construction contractor will provide redundant observations 24 hours a day during construction.

Specific protocol, such as construction observation, will be in place during the initial dredging of the ocean bar channel at New River Inlet to determine if clay is being placed on the beach and to alter dredge practices to prevent any additional clay from being dredged. These protocols will include coordination of observers and the contractor to alter dredge and fill activities if incompatible material is observed to be dredged and placed on the beach. If incompatible material is placed on the beach, the USACE and appropriate resource agencies will be contacted immediately to determine appropriate actions.

During construction of portions of the shoreline where coarse material will be placed to implement the point of intercept concept, regular sediment monitoring will be conducted. The Town, the Engineer, or their duly authorized representative, will collect a representative sub-surface (6 in below grade) grab sediment sample from each 100-ft long (along the shoreline) section of the constructed beach to visually assess grain size, wet Munsell color, granular, gravel, and silt content. Each sample will be archived with the date, time, and

location of the sample. Samples will be collected once each day (as needed to achieve 100 ft intervals) during beach observations. The sample will be visually compared to the acceptable sand criteria (Table 24). If determined necessary by the Engineer, or his duly authorized representative, quantitative assessments of the sand will be conducted for grain size, wet Munsell color, and content of gravel, granular and silt. A record of these sand evaluations will be provided within the Engineer's daily inspection reports. All samples will be stored by the Engineer or the Town for 60 days after project completion.

Upon completion of a pay section along the project where the point of intercept concept is being applied, which includes a USACE baseline monument (i.e. every 1000 ft (900+00, 910+00, 920+00, etc.)), the Town, the Engineer, or his duly authorized representative, will collect a representative sub-surface (6 in below grade) sand sample from the berm at each USACE baseline beach profile line to quantitatively assess the grain size, wet Munsell color, and content of granular, grave, and silt for compliance. Sieve analyses are conducted in accordance with American Society for Testing and Materials Standard Materials Designation D422-63 for particle size analysis of soils (ASTM, 2004) using the sieve set listed in Table 25. The Town, the Engineer, or his duly authorized representative will submit sediment testing results to the USACE – Wilmington District within 24 hours of analysis.

The same procedure as described above will be conducted during construction of all other portions of the beach fill not employing the point of intercept concept; however, no quantitative sediment analysis will be required. Acceptable grain sizes for all other portions of the beach fill are between 0.13 mm and 0.40 mm. Daily observations of grain size, color, shell content, granular content and gravel content of placed material will be performed at a 100 linear ft increment. An attempt to visually estimate the silt content will be made. If the fill material appears to have more than 5% silt, a sample will be collected and sediment analysis conducted.

Table 24
Acceptable sediment parameters for areas where point of intercept will be used

Sediment Parameters	Acceptable Values
Mean Grain Size (1)	0.28 mm to 1.72 mm
Maximum Carbonate Percentage (2)	41%
Maximum Silt Percentage (2)	6.50%
Maximum Granular Percentage (2)	6.07%
Maximum Gravel Percentage (2)	5.43%

Note: (1) Mean grain size is determined using sieves in Table 25
(2) Based off of native beach sampling and allowable State levels.

Table 25
Mesh Sizes Used for Granularmetric Analysis

SIEVE No	SIZE (phi)	SIZE (mm)
3/4	-4.25	19.00
5/8	-4.0	16.00
7/16	-3.5	11.20
5/16	-3.0	8.00
3 1/2	-2.5	5.60
4	-2.25	4.75
5	-2.0	4.00
7	-1.5	2.80
10	-1.0	2.00
14	-0.5	1.40
18	0.0	1.00
25	0.5	0.71
35	1.0	0.50
45	1.5	0.36
60	2.0	0.25
80	2.5	0.18
120	3.0	0.13
170	3.5	0.09
200	3.75	0.08
230	4.0	0.06

6.2.4 Upland Disposal

As previously stated, it has been determined that incompatible material within the designed template of the proposed ocean bar channel exists below a layer of beach quality material. Dredge cuts have been designed and monitoring protocol will be in-place to avoid placement of this material on the beach. The Town will work with the dredge contractor to dispose of the incompatible material on the dredge disposal island located at the junction of the AIWW and Cedar Bush Cut (Figure 18). A dike will be constructed around the portion of the disposal site where material is to be placed with an approximate elevation of +30' NAVD88. The Town will work with the dredge contractor to put in place protocol such as properly placed outfall pipes and construction of weirs to assure that water flowing back into the AIWW via the outfall pipe will meet state water quality standards. At this time final design of the dike improvements and placement of outfall pipe have not been completed as these tasks will be completed during the plans and specifications phase; however, it should be noted that dike improvements will not impact tidal marsh.

6.3 CONSTRUCTION SCHEDULE

Dredging of the ocean bar channel at New River Inlet and nourishment of North Topsail Beach with dredged material from the ocean bar channel and offshore borrow area are scheduled to occur between November 16th and March 31st. The timing of construction activities was specifically scheduled to occur outside of the sea turtle nesting season, the West Indian manatee summer occurrence in North Carolina, the piping plover (and other shorebirds) migratory and breeding seasons, and the seabeach amaranth flowering period. Also, sand placement and dredge operation conducted outside of primary invertebrate production and recruitment periods (spring and fall) limit impacts to amphipods, polychaetes, crabs and clams.

6.4 MONITORING INITIATIVES

Several monitoring initiatives are either currently in-place or have been proposed for the North Topsail Beach Shoreline Protection Project. A description of existing and proposed monitoring initiatives is included below.

6.4.1 Piping Plover (*Charadrius melodus*), Waterbirds and Other Shorebirds

The Marine Corps Base at Camp Lejeune (MCB) has been conducting bi-weekly monitoring of shorebirds on Onslow Beach since 2000. Beginning in April, and throughout nesting season, monitoring intensifies. If piping plovers are observed during nesting season, the surveyors will monitor for signs of breeding behaviors. To date, nesting of piping plovers has not been observed on Onslow Beach. In the event that a nest is located within or outside of the military zone, appropriate protective measure will be implemented. These protective measures may include post and rope with signage indicating that threatened species nests are present. Additionally, off-road recreational vehicle (ORRV) beach access is restricted to the south end of Onslow Beach between April 1 and August 31 (USMC, 2006).

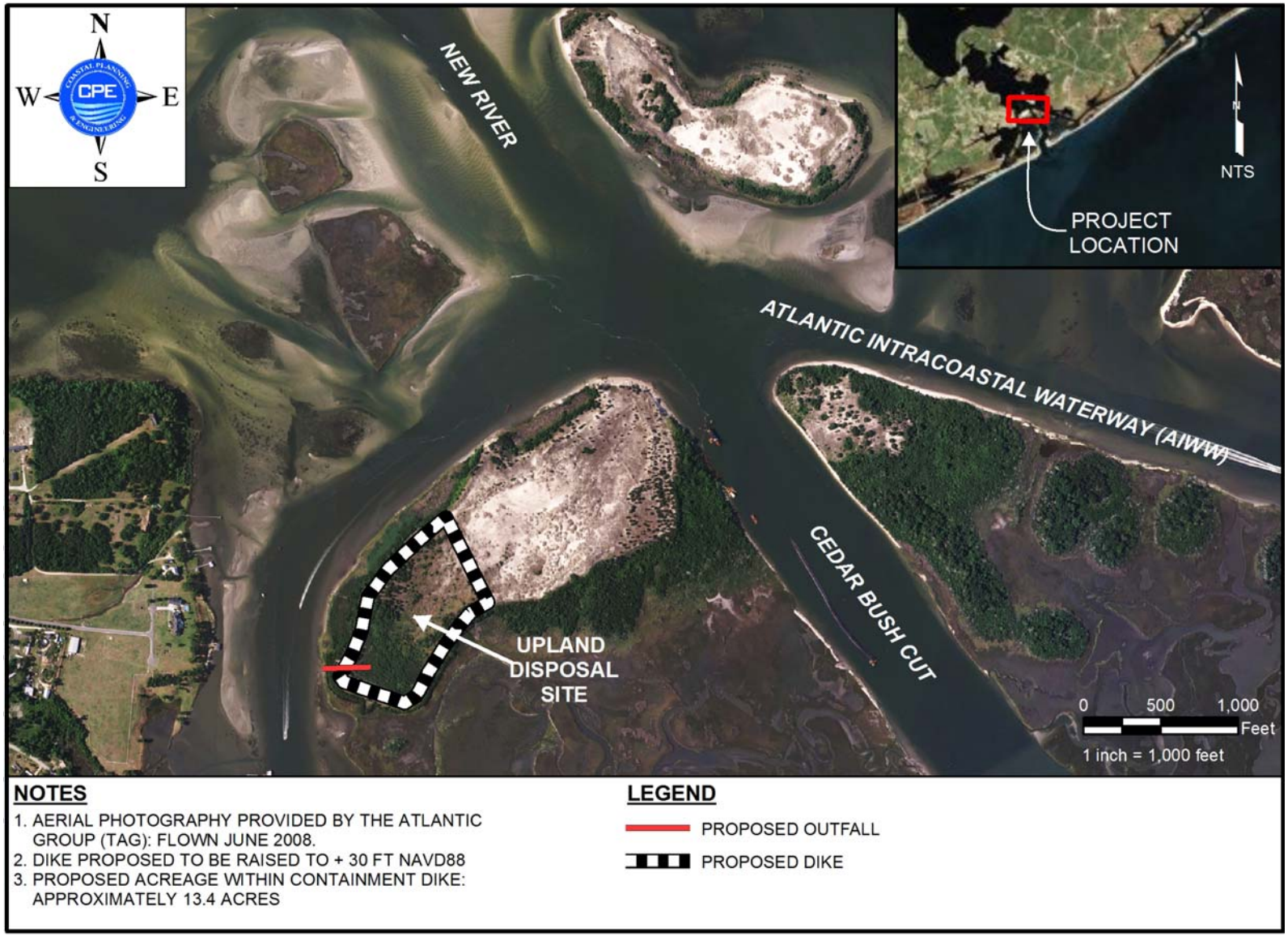

Figure 18. Map depicting the proposed upland disposal area.

A pre-construction bird monitoring plan has been developed by Coastal Planning & Engineering of North Carolina, Inc. Pre-construction monitoring includes bird habitat along the Inlet shorelines, the north end of North Topsail Beach and the south end of Onslow Beach. Post-construction monitoring focuses on areas along the inlet. The Plan includes monitoring of piping plover, waterbirds, colonial waterbirds and other shorebirds before, during and after construction. These monitoring efforts will occur within the Inlet complex to provide information on bird habitat utilization within the Permit Area.

6.4.1.1 Bird Monitoring

The Bird Monitoring Plan has been developed to collect observational data of the federally listed piping plover (*Charadrius melodus*), other shorebirds, waterbirds and colonial waterbirds that may utilize the New River Inlet complex. Piping plovers have been observed using the New River Inlet area during migration and winter, though they have not bred there for about 12 years (Cameron, pers. comm.). Annual surveys of breeding piping plovers are conducted by the North Carolina Wildlife Resources Commission (NCWRC). However, limited information is available on non-breeding piping plovers on the north end of North Topsail Beach. The NCWRC Shorebird Database has records of 89 piping plover sightings from 2000-2004 (S. Cameron, pers. comm.). Surveys conducted by the Marine Corps Base, Camp Lejeune Environmental Division counted 21 piping plovers on Onslow Beach between 2000 and 2004, though no nests have been documented there (S. Brewer, pers. comm.).

6.4.1.2 Purpose and Goals

The Bird Monitoring Plan has been developed in support of this Final Environmental Impact Statement for the North Topsail Beach Shoreline Protection Project. This plan is intended to provide information on indigenous and migratory bird species found nesting, roosting, and foraging along the inlet shorelines and shoal areas of New River Inlet. Data obtained from the bird surveys will determine positive and/or negative effects from the inlet channel relocation efforts to breeding, migrating and wintering birds utilizing the inlet complex.

The plan will provide one-year of pre-construction baseline data on birds utilizing the area. Bird monitoring activities conducted mid- and post-construction will utilize the same methods described in this plan. Transect areas will focus on the Inlet complex to establish any changes in species usage before, during and after realignment of the main ebb channel.

6.4.1.3 Site Selection

Bird monitoring areas were selected based on potential direct and indirect effects to the intertidal and beach habitats within New River Inlet as a result of the ocean bar channel relocation efforts and the nourishment of Phase 1. The Permit Area boundaries identified within the Inlet assisted in determining the extent of the transect areas, which are presented in Figure 19 and described as follows: Transect No. 1 Riverside of North Topsail Beach inlet shoreline beginning at River Road; Transect No. 2 Oceanside of North Topsail Beach inlet shoreline beginning at the southeastern end of Topsail Reefs Condominiums and ending at River Road; Transect No. 3 Onslow Beach inlet shoreline extending approximately 1,060 m (3,500 ft) to the northeast; Transect No. 4 shoal formations approximately 609 m (2,000 ft) north of inlet mouth; and Transects No. 5a and 5b subtidal habitat of New River Inlet and oceanfront surf zones of Transects 2 and 3.

6.4.1.4 Observation Methods

Species observations will be conducted with the use of a spotting scope and binoculars to identify nesting, roosting, foraging, territory establishment, courtship and copulating activities within the transect areas. Observations of breeding sites and nesting pair counts will be included as part of the report documentation, as well as observations and recording of eggs, chicks and fledged individuals.

A standardized field data form will be used for documenting bird species use and habitat dependence in the monitored areas. The number of species and their associated activities will be accounted for in each of the surveyed habitats. The following will also apply:

- Species flying overhead of a surveyed habitat will be reported as flying;
- Birds observed as diving or floating in the nearshore will be reported as utilizing surf zone habitat;
- Banding combinations identified on species of shorebirds and colonial waterbirds, including piping plovers, will be recorded in the notes column to assist in identifying population migration patterns;
- Species observations along the dry beach habitat of the inlet shorelines will extend up to the landward edge of the frontal dune or edge of vegetation, whichever comes first; and
- Bird species observed, but not currently listed as a species will be identified and accounted for under “Other Species”.

Figure 19. Bird Monitoring Areas

Field observations will be conducted during daylight hours. Pre-construction surveys occurred primarily during high tide for each event, based upon recommendations by NCWRC, with a minimum of one low tide survey per month. Only one high tide survey event was required for the winter months (December, January, and February). Post-construction surveys will be conducted in the same fashion as pre-construction to maintain consistency.

Observations along narrow beach habitats will be conducted by walking along the beach. Wider, open areas such as washover habitats will involve walking in a zigzag pattern to observe all birds utilizing the area. Mixed flocks of roosting shorebirds will be surveyed so that all species are accounted for. Surveys will not be conducted during inclement weather conditions (high winds > 20 mph, heavy rains, and/or below freezing conditions). A boat may be used for accessing shoal transect areas and inlet habitats. The use of ATV's or similar vehicles will not be used on the beach during surveys.

Observation survey areas will adjust to changing conditions (e.g. erosion, accretion). A handheld GPS unit with WAAS capabilities and an accuracy of $\leq$3 m will be used during data collection for mapping limits of transect areas. The mapped areas will be used to calculate relative abundance.

6.4.1.5 Pre-Construction Monitoring Schedule

Pre-construction monitoring began in November 2007 and ended in May 2009. Monitoring efforts were consistent with the piping plover breeding season, as well as the spring and fall migration periods. Pre-construction monitoring was conducted approximately every 10 days during spring migration (March 1 to April 30); approximately every 15 days during breeding season (May 1 to July 13); and approximately every 10 days during fall migration (July 14 to November 30). Monitoring during the wintering season (December through February) occurred on a monthly basis during high tide.

6.4.1.6 Mid-Construction Monitoring

A weekly bird monitoring schedule is proposed to occur during construction activities.

6.4.1.7 Post-Construction Monitoring Schedule

The monitoring frequency will return to the pre-construction schedule as soon as all construction equipment has been demobilized from the project area. In the event that the phased construction approach is applied to the project (Alternative 3), post-construction monitoring efforts will be reviewed and coordinated with the USACE, NC DCM and NCWRC. The length of post-construction monitoring will be dependent on the review the data by the USACE, NCDCM, and NCWRC.

6.4.1.8 Reporting

Bird data sheets will be by electronic mail along with an annual. The annual reports will include species richness and abundance analyses for shorebirds and waterbirds. Reports will be prepared and distributed to the USACE, USFWS, NCDCM, and NCWRC within 90 days after the end of the monitoring year.

6.4.2 Seabeach Amaranth (*Amaranthus pumilus*)

Seabeach amaranth is currently monitored by the MCB along the southern end of Onslow Beach. No known seabeach amaranth field surveys have been conducted on North Topsail Beach. Surveys conducted on Onslow Beach, commence in late June and include the upper beach between the wrack line and primary dune line, and all overwash flats. Surveys are completed by two to five personnel on foot. Plants are counted and recorded, and GPS coordinates data are collected to mark population clusters. Once discovered, seabeach amaranth sites are designated by signs to prohibit military, motorized vehicle and pedestrian traffic from disturbing the plants. Post and rope is also used to mark potential habitat on overwash flats and restrict access to vehicular traffic (USMC, 2006). Other threatened species that utilize these same habitats will benefit from the protective and restrictive measures implemented by the USMC.

6.4.3 Sea Turtles

For more than 10 years the Karen Beasley Sea Turtle Rescue and Rehabilitation Center has managed the Topsail Island sea turtle monitoring program. Monitoring includes morning surveys of the beach during nesting season (May through August) identifying and documenting sea turtle tracks and nests (KBSTRRC, 2006). Monitoring is conducted by the Topsail Island Volunteer Organization, whose activities are coordinated under the North Carolina Wildlife Resource Commission Sea Turtle Project. Monitoring efforts also include posting or relocation of nests as needed.

Along Onslow Beach, the MCB has been monitoring approximately 11 miles of Onslow Beach since 1979. Camp Lejeune personnel and/or volunteers perform annual night and morning surveys from mid-May through August, documenting the location and number of sea turtle crawls, recording individual size data, and allowing for immediate protection of sea turtle nests (posting or relocation). Any nests discovered in the designated military training portion of Onslow Beach, or nests laid below the mean high tide line, are eligible for nest relocation. Nests are checked for hatchling emergence or predation, and hatchling tracks are documented to estimate hatchling success (USMC, 2006).

Monitoring and tracking of sea turtles along Topsail Island and Onslow Beach are expected to continue during the life of the project. These efforts will assist in identifying whether project related activities are affecting sea turtle nesting populations. However,

as a result of the posting and relocation efforts, impacts to sea turtles from project activities are not anticipated.

Additionally, escarpments can prevent sea turtles from accessing the dry beach and cause the female to return to the water without nesting. Visual surveys of escarpments along the project area will be made after completion of project construction. An elevation exceeding 45 cm (18 inches) may require remedial measures to eliminate or minimize escarpments.

6.4.4 West Indian Manatee (*Trichechus manatus*)

The West Indian manatee can be found in shallow waters (1.5 to 6.1 m) [5 to 20 ft]) of varying salinity levels including coastal bays, lagoons, estuaries and inland river systems. *T. manatus* have been recorded in North Carolina and are most likely to occur from June through October when water temperatures are warmest (temperatures above 23.9ºC (75ºF)) (Schwartz, 1995; USFWS, 2006f; USFWS, 2001b). According to the USMC, a dead manatee was found in the New River in January 2004. Although the manatee is not expected to be present during dredge and fill operations, the contractor will adhere to the precautionary guidelines established by the USFWS – Raleigh Office for construction activities in North Carolina waters. Refer to the *Guidelines for Avoiding Impacts to the West Indian Manatee*.

West Indian manatees rely on submerged aquatic vegetation (SAV) as a food source. Aerial imagery analysis conducted pre- and post-construction will be used to monitor any changes in SAV distribution. Aerial imagery will be collected in accordance with NOAA's Coastal Services Center 2001 *Guidance for Benthic Habitat Mapping – An Aerial Photographic Approach* (Finkbeiner et al., 2001). Aerial photographs include the acquisition of ortho-rectified color digital imagery of the Permit Area. Resolution of the acquired imagery will be sufficient (<0.6 m [2 ft]) to accurately delineate and map habitats and features of environmental significance within the survey area. An emphasis will be placed on those marine and estuarine habitats located immediately within and adjacent to the Permit Area. The aerial platform from which the imagery is acquired will inlcude an onboard Global Positioning System (GPS) that will provide an accurate basis for product correction.

6.4.5 Macroinfauna

Some macroinfaunal species may be sensitive to physical and chemical changes in water quality and, therefore, may be useful as bioindicators of a wide range of natural and anthropogenic stresses. It is known that benthic communities can withstand some burial and invertebrate populations will recover within weeks or months with the use of high quality beach fill material and the appropriate timing of placement. A monitoring plan or research initiative for the evaluation of oceanfront shoreline infaunal communities as described below and will be implemented by Dr. Skip Kemp of Carteret Community College.

6.4.5.1 Introduction

The proposed initiative follows a 2-year project with the Town of Emerald Isle, which examined the feasibility of harvesting, holding and propagating *Donax* spp. for resource enhancement aquaculture. That project concluded with four important results:

1. The most efficient sieve size and depth for harvesting *Donax* was 3-mm square mesh and 2-centimeters, respectively.
2. Environmental (summer) and behavioral (patchy aggregations) parameters were important guidelines for improving the numbers of *Donax* harvested.
3. The best management practice for long-term holding of *Donax* was determined to be upwellers with high flow rates, high densities and raw seawater.
4. Aquaculture propagation was initiated for *Donax* with development of photographic gonad development indices and use of environmental manipulation to achieve spawning.

6.4.5.2 Project Goals

The overall goal of this project is to examine the feasibility of replanting *Donax* for resource enhancement following beach nourishment.

6.4.5.3 Objectives

The objectives of this initiative are three fold.

1. Direct transplants of *Donax* from pre-nourished to post-nourished beach
2. Collection and holding of *Donax* when most seasonally available for replanting to post-nourished beach in a designed experiment.
3. Attempt to assess recruitment of juvenile *Donax* to planted areas and control areas.

6.4.5.4 Methods

Harvest: To improve the quantities of clams harvested by our hand-harvesting methods, we will design, construct, and test devices for the purpose of mechanically harvesting large numbers of *Donax*. We will adapt our prototype handle-pulled harvester and other commercially available designs as prototypes for developing a lightweight portable device that can be transported and actuated with a typical 4-wheel drive ATV or small rental tractor. The device will direct an adjustable layer of beach substrate with *Donax* into a detachable harvest container or into a vibration sieve separator. The separator was successfully tested during the previous project. Several prototype devices will be built and tested during the summer before beach nourishment for use during the actual nourishment project. We will compare the catch rates per unit effort of mechanical gear with that of the typical hand-harvest methods using project labor but also by engaging the CCC aquaculture practicum class on several occasions. In addition we will recruit help from environmentally

conscientious groups such as PenderWatch and the Boy Scouts. This was used successfully in the previous project and adds a community education and conservation element to the project.

Mark: To improve estimates of survival from recaptures we will test several markers for released clams. Marked clams will be dyed, painted or etched to determine the most effective and feasible large-scale tag-and-release marker. This will also utilize the CCC aquaculture students and others such as the CCC Science club because the work load is expected to be high for this task. This will create another opportunity for community involvement and education.

Move: *Donax* collected in the summer when seasonally most abundant will be moved to the CCC aquaculture facility and held in special purpose upwellers until the time for replanting. The facility will be outfitted with a redundant submersible pump system and pipes to handle the increased water supply needs. Large upweller containers will be built and fitted to existing tanks. Clams collected during the beach nourishment project will be moved directly from the pre-nourished to the post-nourished beach.

Replant: *Donax* will be marked and released in several areas of post-nourished beach and will be recaptured using standard 4-inch diameter core-sampling device to determine the survival of clams. Replants will be released at high and low densities, to be determined and prorated based on actual harvested numbers, in test plots and recaptured methodically and over a given time frame beginning immediately after release and extending over an adequate time frame to determine the difficulty and degree of recapture. Replants of *Donax* clams will be conducted in winter during the nourishment project as well as in spring when waters are warming and spawning commences. GPS will be used to identify the general locations of planted plots and identifier stakes will be employed as temporary marks of the exact deployment site.

Follow: Plots of released clams will be sampled over an extended time frame to attempt to estimate long-term survival rates. Recaptures will be removed from the experiment and used in future deployments. A recapture grid will be constructed and a system for labeling the locations and numbers of recaptures will be used to estimate survival rates.

Recruit: To increase the recruitment of juvenile *Donax* to newly nourished beaches is of course the greatest interest and the ultimate goal of the project. It is also likely the most difficult to determine conclusively. Consequently a large amount of effort will be devoted to determining the numbers and sizes of juvenile *Donax* before and after the deployment of clams in planted and control areas. Additionally, the abundance of adults will be assessed as an indicator of spawner biomass. Numbers and sizes of juvenile clams caught will be compared between the months prior to deployment of replanted plots and the months after deployment in and around both treatment and control areas. Because *Donax* typically spawn in the spring we will

deploy a significant amount of effort during the time shortly after the spawning season.

Prepare: The CCC Aquaculture facility will be outfitted with a redundant system of submersible pumps, pipes and upwellers that can handle large numbers of clams and increased demand on the system. A project operator and interns will be employed to conduct the project and to keep the CCC aquaculture facility maintained and functional. Harvesters and sampling gear will be designed and fabrication will begin. Testing of harvester designs will commence. Required materials and equipment will be purchased and employed in a timely manner to insure the successful execution of the project.

6.4.5.5 Deliverables

Deliverables for the project will include all *Donax* harvested, which will be released to the nourishment project site. In addition to timely progress reports, a final interpretive report will also be provided. This initiative may also result in the presentation of the results at aquaculture conferences as well as the submission of the research to peer-reviewed journals.

6.4.6 Habitat Mapping

6.4.6.1 Purpose and Goals

It is anticipated that the implementation of inlet management portion of the proposed project has the potential to impact a number of biological resources found within the proposed Permit Area. These include resources such as submerged aquatic vegetation (SAV), shellfish habitat, salt marsh and fringing terrestrial communities found within the supratidal, intertidal, and subtidal habitats. Determining the baseline conditions of these resources prior to construction is a fundamental step in quantifying changes in response to the implementation of the inlet management plan. Existing data and newly acquired data will be utilized to delineate and characterize habitats and select species within the proposed Permit Area. Data gathered from these activities will provide the baseline conditions. The purpose of this baseline habitat mapping effort is to identify the current extent of the biological resources within the area prior to the construction of the ocean bar channel and will serve as the baseline assessment of these resources. Subsequent habitat mapping efforts will be utilized to assess the extent of change to these habitats following construction activities. This plan was developed in response to the concerns expressed by the USACE, USFWS, NMFS and the NCDENR.

6.4.6.2 Monitoring Schedule

Several sets of pre-project high resolution color aerial photographs are available by the USACE including those taken in April 2006 and June 2008. Pre-construction photographic interpretation of biotic communities and groundtruthing investigations

within the Proposed Habitat Mapping Area (Figure 5) will be completed prior to construction of Phase 1.

The acquisition of high resolution aerial photographs, ground-truth investigations, and identification of biotic communities will be conducted within the Proposed Habitat Mapping Area between 1 September and 30 November in the 4 years following construction of the ocean bar channel. All surveys will be compared to the pre-construction conditions (November 2010).

6.4.6.3 Monitoring Parameters

Aerial Photography: Cartographic aerial photography will include the acquisition of ortho-rectified color digital imagery of the 1120 acre proposed habitat mapping area. Resolution of the acquired imagery will be sufficient to accurately delineate and map habitats and features of environmental significance within the survey area. An emphasis will be placed on those marine and estuarine habitats located in or near the proposed ocean bar channel. The aerial platform from which the imagery is acquired will have an onboard GPS that will provide an accurate basis for product correction. NMFS will be consulted regarding the performance specifications on the imagery prior to finalizing the plan by the Town and authorizing a contract.

In compliance with State and Federal agency requests, digital image acquisition will be scheduled, to the greatest extent possible; to coincide with good weather conditions and an ebb tide that may provide for increased accuracy of habitat interpretation. Considering the weather-dependent nature of this activity, every effort will be made to accomplish this task under optimum conditions.

Submerged Aquatic Vegetation: Resource maps depicting SAV communities along coastal North Carolina do not show SAV communities occurring within the Permit Area or vicinity of the ocean bar channel in New River Inlet. CPENC's coordination with the NCDMF confirmed the absence of SAV in the area based on limited field investigations (A. Deaton, pers. comm.). However, recent aerial photography has indicated a potential for SAV and/or oyster shell habitat to occur in the vicinity of the upland disposal area located at the junction of the AIWW and New River Inlet. The pre-construction habitat change analysis and field investigations will confirm the presence/absence of this habitat type.

In order to verify these initial observations, the absence of SAV resources within the Habitat Mapping Area will be confirmed using visual observations in shallow water and snorkeling in waters where the vegetation and/or bottom are not visible due to decreased water clarity. GPS will be used to ascertain the general limits of any identified SAV occurrences.

Shellfish Resources: The NCDMF Shellfish Mapping Program has mapped the general location of shellfish habitats, and have identified strata W (intertidal hard, non-vegetated, with shell) and strata V (intertidal hard, vegetated without shell) in and

around the New River Inlet where oysters (*Crassostrea virginica*) and hard clams (*Mercenaria mercenaria*) can be found (C. Caroon, pers. comm.; B. Conrad, pers. comm.). Benthic habitat surveys within this area were conducted in 1991 and 1992 by the NCDMF (C. Conrad, pers. comm.). While the 1992 data does not confirm the absence of shellfish in the Permit Area, it does confirm that none were found at the time of sampling and that most of the Permit Area is absent of potential shellfish habitat. In order to verify these initial observations, the location and extent of shellfish resources within the Habitat Mapping Area will be determined using visual observations in shallow water and snorkeling in waters where the vegetation and/or bottom are not visible due to decreased water clarity. GPS will be used to ascertain the general limits of any identified shellfish resources.

Salt Marsh and Terrestrial Fringing Communities: Visual interpretations of salt marsh and terrestrial fringing communities will be digitally mapped using GIS software over high resolution georeferenced digital multispectral aerial photographs. The methods employed for interpretation of aerial photography included visual analysis of color variations in the photographs to delineate habitats (dark areas = submerged land; white areas = sediment exposed above high tide line). Resolution of this imagery (< 2 feet) allowed for adequate delineation of the habitats and features within the Habitat Mapping Area. Following the development of the preliminary biotic community mapping within this domain via visual interpretation, field investigations will be conducted to groundtruth the initial delineations. Sites selected for groundtruthing will be determined by identifying areas that are difficult to classify from the aerial photography. These locations will be visited via boat and the biotic community type (as identified through aerial photographic interpretation) was then verified. Based on the results of the field investigations, the preliminary habitat map will revised as necessary and acreages will be determined.

6.4.6.4 Reporting

The final product to be delivered is a biotic community map of the Habitat Mapping Area based upon rectified (geo-referenced) mosaic images. Results of the mapping efforts will be incorporated into the Global Information System (GIS) database developed for this project. Acreages of each habitat type present within the permit area will be provided in a report to the USACE – Wilmington District, NMFS, USFWS, NCWRC, and NCDCM by January 1st of each year.

6.4.7 Hardbottom Monitoring

Natural resources in the nearshore and offshore zones of the Permit Area have been mapped by CPENC professionals using side-scan sonar investigations and diver verification in an effort to avoid and minimize potential impacts to these resources. Included is an analysis of existing literature and information that provides the rationale for establishing a buffer zone limit of 121.9 m (400 ft) for all hardbottom resources in the Permit Area. The 121.9 m (400 ft) limit is less than the State standard of 500 m (1,640 ft) (15A NCAC 07H. 0208(b)(12)(A)(iv)). However, based on over 40 years of dredging experience in less turbid southeast Florida waters adjacent to sensitive habitats, borrow area buffer zones ranging from 76 m (250 ft) to 122 m (400 ft) have proven effective in protecting hardbottom and coral reef habitats. The potential turbidity impacts associated with project activities are not expected to be significantly different from those associated with disturbance which occurs during storm (higher wave energy) events. Monitoring of both borrow site and beach nourishment site turbidity levels can be utilized to assure compliance.

As designed, the project is not expected to impact nearshore hardbottom resources that are located immediately adjacent to and within the Permit Area. A Hardbottom Monitoring Plan has been developed for the Permit Area and includes physical and biological monitoring of the nearshore and offshore hardbottom communities located in the vicinity of the central and south fill areas, as well as the borrow area.

6.4.7.1 Research and Development

In November 2004, April 2005 and August 2006, CPENC geologists conducted side-scan sonar surveys of the nearshore and offshore regions of North Topsail Beach and along the nearshore area of Onslow Beach. The side-scan sonar data were analyzed and compared to shoreline profiles to determine potential and probable hardbottom resources located in the nearshore of the proposed fill areas and in the vicinity of the offshore borrow area.

CPE marine biologists conducted *in situ* investigations in June, August and October 2005 and August 2006 to confirm the nearshore and offshore delineations of potential and probable hardbottom resources. Field investigations confirmed hardbottom resources located in -15 ft to -21 ft NAVD, approximately 350 m (approximately 1,150 ft) offshore of the February-March 2002 mean high water; and offshore hardbottom areas located 121.9 to 304.9 m (400 to 1,000 ft) from the offshore borrow area. In August 2005, ten (10) temporary transects (TS5 to TS15) were established (Figure 20).

In June 2006, the southern fill section was added to the Permit Area. In August 2006, sea conditions supported the acquisition of side-scan survey data in the nearshore zone of Stations 581+80 to 780+00 and offshore near the borrow

area. CPE marine biologists field verified the side-scan data at the end of August 2006.

The monitoring plan for nearshore and offshore hardbottom will include habitat characterization along nearshore and offshore transects, sidescan sonar surveys, sediment monitoring, and beach profile surveys. Table 26 shows the breakdown of the proposed hardbottom monitoring (hardbottom transects, sidescan sonar, sediment monitoring, and beach profiles) for each phase of initial construction. The table is structured in such a manner that the associated monitoring is only that which is being proposed for dredging of material from the proposed borrow site for that phase and placement of fill along that stretch of shoreline defined by the particular phase. Proposed monitoring for Phases that include both an initial construction event and a re-nourishment event (i.e. Phase 3 includes initial construction of Phase 3 and re-nourishment of Phase 1) would include monitoring shown in Table 26.

6.4.7.2 Transect Establishment

Hardbottom monitoring will include the establishment of permanent monitoring transects in the nearshore and offshore hardbottom resource areas coinciding with the 2005 and 2006 baseline investigations. The permanent biological monitoring stations will include stainless steel pins that will be installed into the hardbottom using a hammer and/or drill at 5.0 m (16.4 ft) spacing along each of the permanent transects. Monitoring of these transects will assist in identifying project effects on natural hardbottom resources. The approximate locations of these transects are shown in Figure 20.

All underwater investigations will be conducted in accordance with the CPE Dive Safety Program. Effort will be made to schedule these field activities when visibility underwater is one meter or greater.

Table 26. Summary of proposed hardbottom monitoring, including hardbottom transects, sidescan sonar, and beach profiles.

Phase	Projected Date	Type	Required	Areas	Pre-Con Date	Post-Con Date
1	16 Nov, 2010 - 31 March, 2011	Nearshore Hardbottom Transects	No	N/A	N/A	N/A
		Offshore Hardbottom Transects	No	N/A	N/A	N/A
		Sidescan Sonar Surveys	Yes	Area 1 [1]	60 days prior to Construction	1st event - between 4 and 6 months post con 2nd event - between 16 and 18 months post-con
		Beach Profile Surveys	Yes	4 Profiles Between 1080+00 and 1065+00	60 days prior to Construction	1st event - between 4 and 6 months post con 2nd event - between 16 and 18 months post-con
		Sediment Monitoring	No	N/A	N/A	N/A
2	16 Nov, 2012 - 31 March, 2013	Nearshore Hardbottom Transects	No	N/A	N/A	N/A
		Offshore Hardbottom Transects	Yes	TS - 9-14, 16-17 C - 3 and 5 [2]	Between June and October Prior to Construction	Between June and October following Construction
		Sidescan Sonar Surveys	Yes	Areas 1, 3, and 4 [1]	60 days prior to Construction	1st event - between 4 and 6 months post con 2nd event - between 16 and 18 months post-con
		Beach Profile Surveys	Yes	14 Profiles Between 1075+00 and 1010+00	60 days prior to Construction	1st event - between 4 and 6 months post con 2nd event - between 16 and 18 months post-con
		Sediment Monitoring	Yes	TS - 9-14, 16-17 C - 3 and 5 [2]	Every 2 weeks (2 months prior to construction)	Every 2 weeks during construction[4] / 30 days prior to construction
3	16 Nov, 2014 - 31 March, 2015	Nearshore Hardbottom Transects	Yes	TS - 5-8 [2] C - 2 [3] and 4 [2]	Between June and October Prior to Construction	Between June and October following Construction
		Offshore Hardbottom Transects	No	N/A	N/A	N/A
		Sidescan Sonar Surveys	Yes	Area 2 [1]	60 days prior to Construction	1st event - between 4 and 6 months post con 2nd event - between 16 and 18 months post-con
		Beach Profile Surveys	No	N/A	N/A	N/A
		Sediment Monitoring	No	N/A	N/A	N/A
4	16 Nov, 2016 - 31 March, 2017	Nearshore Hardbottom Transects	No	N/A	N/A	N/A
		Offshore Hardbottom Transects	Yes	TS - 9-14, 16-17 C - 3 and 5 [2]	Between June and October Prior to Construction	Between June and October following Construction
		Sidescan Sonar Surveys	Yes	Areas 3 and 4 [1]	60 days prior to Construction	1st event - between 4 and 6 months post con 2nd event - between 16 and 18 months post-con
		Beach Profile Surveys	No	N/A	N/A	N/A
		Sediment Monitoring	Yes	TS - 9-14, 16-17 C - 3 and 5 [2]	Every 2 weeks (2 months prior to construction)	Every 2 weeks during construction[4] / 30 days prior to construction
5	16 Nov, 2018 - 31 March, 2019	Nearshore Hardbottom Transects	Yes	TS - 18-19 [2] C - 2 [3] and 4 [2]	Between June and October Prior to Construction	Between June and October following Construction
		Offshore Hardbottom Transects	Yes	TS - 9-14, 16-17 C - 3 and 5 [2]	Between June and October Prior to Construction	Between June and October following Construction
		Sidescan Sonar Surveys	Yes	Areas 3 - 5 [1]	60 days prior to Construction	1st event - between 4 and 6 months post con 2nd event - between 16 and 18 months post-con
		Beach Profile Surveys	No	N/A	N/A	N/A
		Sediment Monitoring	Yes	TS - 9-14, 16-17 C - 3 and 5 [2]	Every 2 weeks (2 months prior to construction)	Every 2 weeks during construction[4] / 30 days prior to construction

[1] Areas shown in Figure 22

[2] Transects shown in Figure 21

[3] Transect not shown on Figure 21

[4] If after 2 months during construction it is found that sedimentation at compliance transects does not exceed control by more than 10% monitoring, requirements will be reduced to one event per month for the remainder of construction.

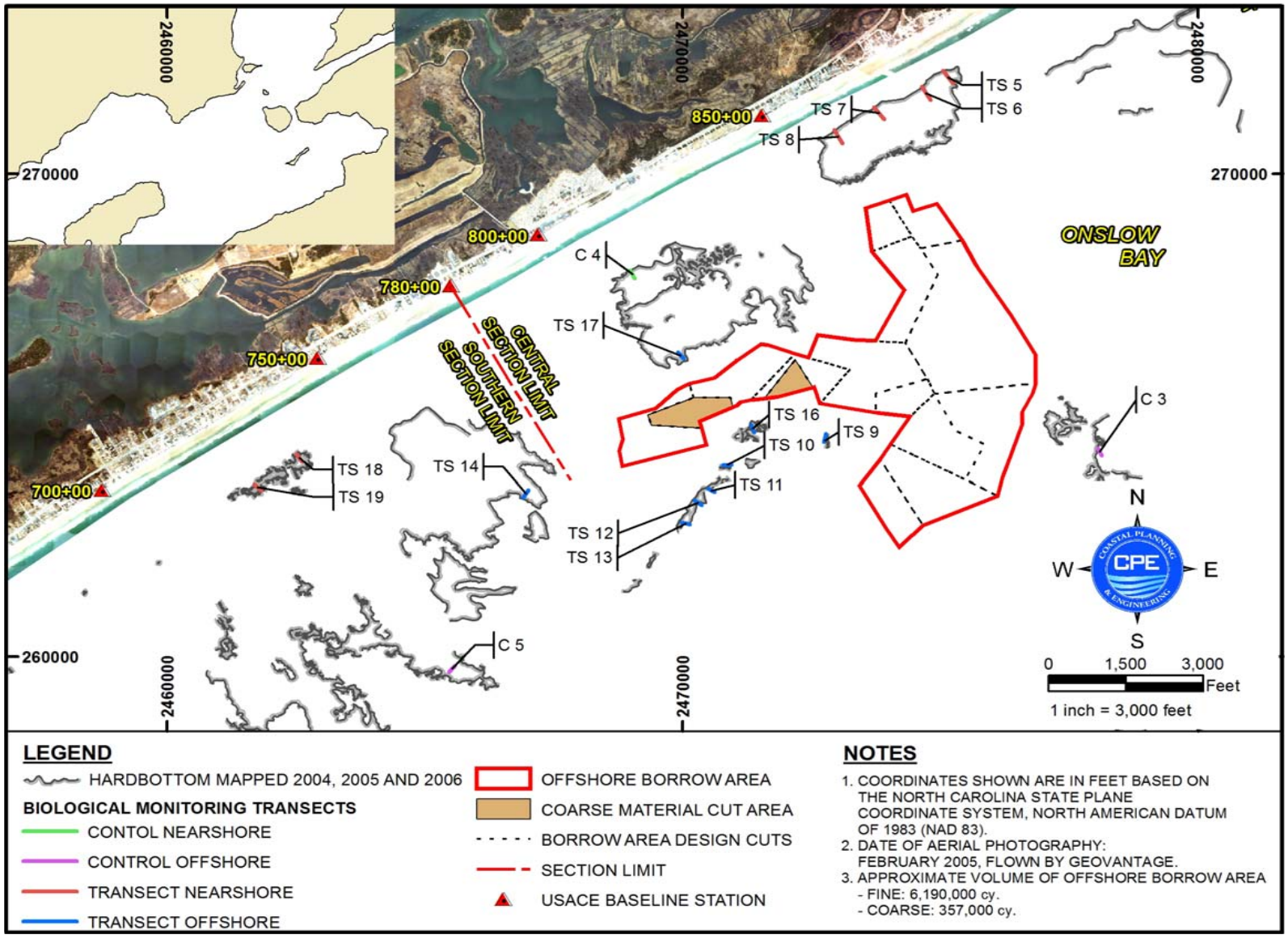

Figure 20. Hardbottom Monitoring Stations

6.4.7.3 Nearshore Hardbottom Transect Locations

Poor visibility in the nearshore resource investigation areas of the Northern Section have prevented marine biologists from both characterizing the habitats and mapping the edge of the resources with any level of confidence. Therefore, this monitoring plan involves pre-, mid-, and post-construction monitoring of the confirmed hardbottom resources in the Central and Southern Sections (Phases 3 and 5). A total of seven (7) permanent transects will be established along the confirmed hardbottom located in the central and south fill areas. In Phase 3, TS5 to TS8 will be permanently established between USACE baseline stations 850+50 and 890+00; and TS18 and TS19 will be permanently established in the Southern Section between USACE baseline stations 720+00 and 740+00. These transects will serve as compliance transects.

The two remaining permanent transects will be added to the monitoring program in order to identify any naturally occurring changes in biotic and abiotic communities in the nearshore environment. These transects will serve as control transects. The first of these two transects will be located near Station 810+00 referred to as C4 (Figure 20). The location of the second transect (C2) will be offshore the northern end of Surf City Town Limits in approximately 7 m (25 ft) of water.

Nearshore transects will be surveyed once prior to construction between June and October, and once following construction between June and October for Phases 3 and 5. The nearshore transects will begin at the shoreward edge of the hardbottom and extend 60 m (approximately 197 ft) in a southeasterly direction, perpendicular to shore. Sampling will occur every 2.5 meters (8 ft).

6.4.7.4 Offshore Hardbottom Transect Locations

Marine resource investigations of the offshore communities conducted in October 2005 and August 2006 included the establishment of eight (8) 50 m temporary transects (TS9 to TS14, TS16 and TS17). Transects were established at the sand/rock interface, extending away from the borrow area. These 8 sites will be the permanent transects monitored between June and October prior to construction. Refer to Figure 20.

The two (2) control transects are proposed for determining natural changes in community cover and to provide comparative data for future dredging activities on proximate hardbottom. These 3 control transects will include: 1) C5, temporarily established in October 2005, located approximately 4,400 feet from the borrow area, and 2) C3 offshore of Station 870+00 in approximately 40 feet of water.

Offshore transects will be surveyed once prior to construction between June and October, and once following construction between June and October for phases that involve removal of material from the offshore borrow site (Phases 2, 4, and 5). The offshore transects will begin at the rock/sand interface and extend 50 meters (approximately 164 feet) in a southerly direction. Sampling will occur every 2.5 meters.

6.4.7.5 Habitat Characterization

Two methods of habitat characterization and documentation were used during the baseline investigations 1) Benthic Ecological Assessment for Marginal Reefs (BEAMR) developed by Coastal Planning & Engineering, Inc. (CPE, 2004a), and 2) digital video that may be used to supplement analysis of hardbottom communities present within each study area. These methods will be utilized when underwater visibility is one meter or greater. Alternative methods (Section 6.4.5.6) are proposed for conditions of less water clarity.

The BEAMR surveying method was developed to evaluate nearshore marine habitats, and determine the interrelationship between corals, algae, sediment, invertebrates, and fish species within nearshore reef systems.

In situ observations will be conducted by CPE marine biologists trained in the procedures and methods of BEAMR. BEAMR methodology involves a complete census of physical, abiotic and biotic functional groups (parameters) within each sample quadrat. Every visible functional group is assigned a number of at least 1% with the total of all functional groups equal to 100%. Functional biotic groups include: macroalgae, turf + algae + cyanobacteria, encrusting red algae, sponge, hydroid, octocoral, stony coral, tunicate, anemone, barnacle, bivalve, bryozoan, *Millepora* sp., seagrass, sessile worm, and zoanthid. Abiotic groups include sediment and bare hard substrate.

Within each quadrant, the maximum vertical relief is measured (to nearest cm) from the maximum lowest to highest point in the quadrat. Maximum standing sediment thickness over hardbottom is determined by acquiring two random measurements and recording the highest of the two values (to nearest cm). In the event that no areas of loose unconsolidated sediment ($\geq$1 cm) exist within the quadrat, then a value of zero is recorded for the station. Percent cover of standing sediment over hardbottom, including sand, shell and mud, is surveyed in each quadrat and reported to the nearest one percent. Natural exposed substrate without turf cover and with or without a veneer of sediment less than 1 cm in height is recorded as bare hard substrate.

Macroalgae will be identified to genus level and the percent cover of each genus will be recorded. Unattached or floating macroalgae will be disregarded. Octocorals and scleractinian colonies will be identified to the lowest practical

taxonomic level and the maximum height or width will be recorded to the nearest cm. Abnormal conditions of each observed colony within the quadrat will also be recorded (e.g., bleaching, disease, stress). These investigations will provide a quantitative and qualitative data set that will be utilized to assess and comparatively evaluate changes in the benthic macroinvertebrate and macroalgal communities at each study site.

BEAMR quality assurance/quality control (QA/QC) includes using qualified marine biologists trained in the BEAMR Standard Operating Procedures. An Access database is used by CPE to manage the BEAMR data collected during baseline investigations. The sample data entry form (Figure 21) incorporates quality control during the data entry process through standardized formatting and summation of functional groups. This process also contributes to quality analysis and quality control of the data after it has been collected in the field.

The BEAMR surveying method was conducted at each of the temporary transects (TS5 to TS15) established in October 2005 and August 2006 (TS16 and TS17). This baseline data will be reported in the pre-construction monitoring report which will be submitted within 90 days of completion of field activities, at latest February 1st of each monitoring year.

Project Name	**Site Name / Transect Name**
Date	**Data Collector**

Quad Label: **Sample Name or #**		List macroalgae Genus % List every coral colony ~and coral condition(s)	% cover or max size (cm)
Max Relief (cm)			
Max Sediment Depth (cm)			
Sessile Benthos…	**% Cover**		
Sediment- (circle all: sand shell mud)			
Macroalgae- Fleshy+Calcareous			
Turf- algae+cyanobacteria (circle all: g r b)			
Encrusting Red Algae			
Sponge			
Hydroid			
Octocoral			
Stony Coral			
Tunicate			
Bare Hard Substrate			
other-…			

Total Must = 100%

Quad Label: **Sample Name or #**		List macroalgae Genus % List every coral colony ~and coral condition(s)	% cover or max size (cm)
Max Relief (cm)			
Max Sediment Depth (cm)			
Sessile Benthos…	**% Cover**		
Sediment- (circle all: sand shell mud)			
Macroalgae- Fleshy+Calcareous			
Turf- algae+cyanobacteria (circle all: g r b)			
Encrusting Red Algae			
Sponge			
Hydroid			
Octocoral			
Stony Coral			
Tunicate			
Bare Hard Substrate			
other-…			

Total Must = 100%

Standard Abbreviations: and abbreviation formats

Macroalgae: Pool to Genus = Genu or Genus: Avra, Bryopsis, Bryothamnion, Caul, Codi, Dasya, Dasycladus, Grac, Hali, Hypn, Sarg…
Octocoral: Genus of each colony = Genu: Gorg, Lept, Plex… except Pseudopterogorgia=Pspt, Plexaurella=Plla, Pseudoplexaura=Pspl
Stony Coral: Genus species of each colony = G spe: A cer, A aga, C nat, M ann, M cav, P ame, O dif, S rad, S sid, S bou, S hya, S int…
Coral condition: W=white disease(s), O=other disease(s), B=bleaching, Coral Stress Index # 0 1 2 3
Other Biota Specified: Anemone, Annelid, Bivalve, Barnacle, Bryozoan, *Millepora* sp., Seagrass, Zoanthid

Figure 21. Sample BEAMR data entry form.
(Note: Each underwater datasheet has four (4) quadrat entry forms on each side.)

6.4.7.6 Alternative Approach to Nearshore Habitat Characterization

Efforts will be made by CPE marine biologists to consistently utilize the BEAMR method along the nearshore transects. As an alternative, in poor visibility water, the point-intercept method and line-intercept methods will be utilized.

The point-intercept sampling method will include species identification to the lowest taxon possible, with measurements of the organisms (i.e., octocoral and stony coral) collected to the nearest centimeter. Species identification and measurement will be conducted on the organisms that occur under or to the right and left side of the incremental marking on tape. The data collected will provide a taxa list for identifying habitat equivalency between the control and compliance transects. Taxa lists will be completed as extinction curves (i.e., species-area curves or dominance tests) and point identification numbers will provide relative abundance.

Line-intercept sampling will be used to assess physical characteristics of the substrate (i.e., sand cover vs. hardbottom exposure). The observer will note the locations along the transect where hardbottom and sand (depths ≥1 cm) intercept. The location of sediment patches greater than 0.5 m in length along the transect will be recorded. The results of the data collected will be used to determine the total substrate area available.

The point-intercept and line-intercept methods can be used in extremely low-visibility conditions (≥10 cm and <40 cm). Sampling frequency and locations will be consistent with BEAMR transects and will occur every 2.5 m along the 60 m transect line.

6.4.7.7 Video Documentation

Video surveys will be conducted of the seafloor along each transect will be taken at a height of 40 cm after Porter et al. (2002). A convergent laser guidance system indicates the precise height of 40 cm from the benthos (see Photo 1). The visible width of imagery taken from this height is 40 cm. Geographic Positioning System (GPS) navigational coordinates (North Carolina State Plane Coordinate System, NAD 83) of the video transect locations will be overlaid on recent aerial photography and included in the project monitoring reports.

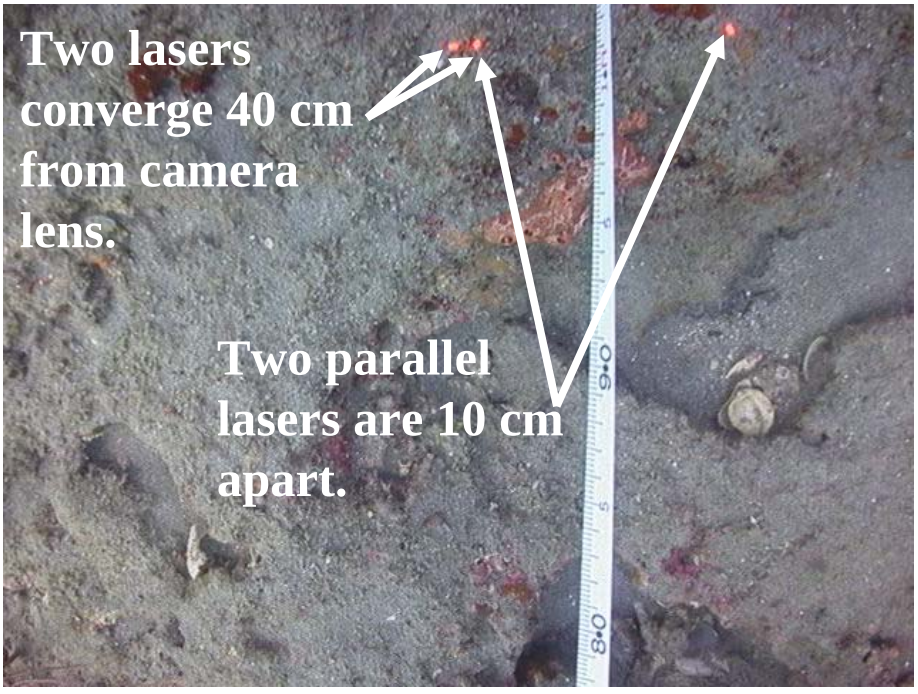

Photo 1 - Video laser guidance system in use on reef substrate.

6.4.7.8 Geophysical Survey (Sidescan Sonar Survey)

Acquisition of high-resolution acoustic imagery of the seafloor followed by hardbottom community analyses will occur along select nearshore and offshore hardbottom features located between USACE baseline stations 580+00 to 1160+00. The surveys will utilize state of the art side-scan sonar technology coupled with a Hypack 2008® navigation system or similar system. Data acquisition will utilize a Trimble DGPS system to provide accurate positioning information. The survey will be conducted in such a manner to achieve total bottom coverage (100%) within the survey area. The line spacing will be set up to achieve 100% overlap (i.e. all areas of the seafloor covered twice).

Geophysical surveys will be conducted along the confirmed hardbottom located 1) in the nearshore zone of the Project Area between -19 and -22 NAVD88 (Areas 1, 2, and 5; Figure 22); 2) along the offshore hardbottom areas northeast of the borrow area (Area 3; Figure 22), and; 3) in the vicinity of TS9 to TS12 and TS16 (Area 4; Figure 22).

Once the data has been processed and reviewed for accuracy and resolution, the data will be input into the Project GIS for analysis. Ground-truthing will be required for identifying select signatures in the acoustic, seafloor imagery to confirm sediment characteristics and community type coverage.

Data collected through this type of monitoring protocol using sidescan sonar coupled with groundtruthing as well as beach profile data, has been shown to provide accurate monitoring of hardbottom exposure and coverage in Collier County, FL (CPE, 2009). Accurate mapping of the seafloor bottom using sidescan sonar can help determine areas where previously exposed rock outcrops have been covered by a thin veneer of sand as well as areas where previously covered areas have been uncovered and are currently exposed. This information will assist in determining Project effects on adjacent nearshore and offshore communities.

One (1) pre-construction event will occur within 60 days prior to construction and two (2) post-construction monitoring events will be conducted. The first post-construction event will occur 4 to 6 months following construction and the second event will occur 16 to 18 months following construction. The results of the pre- and post-construction data collection events will be included in the post-construction biological monitoring report submitted by February 1st of each year at the latest.

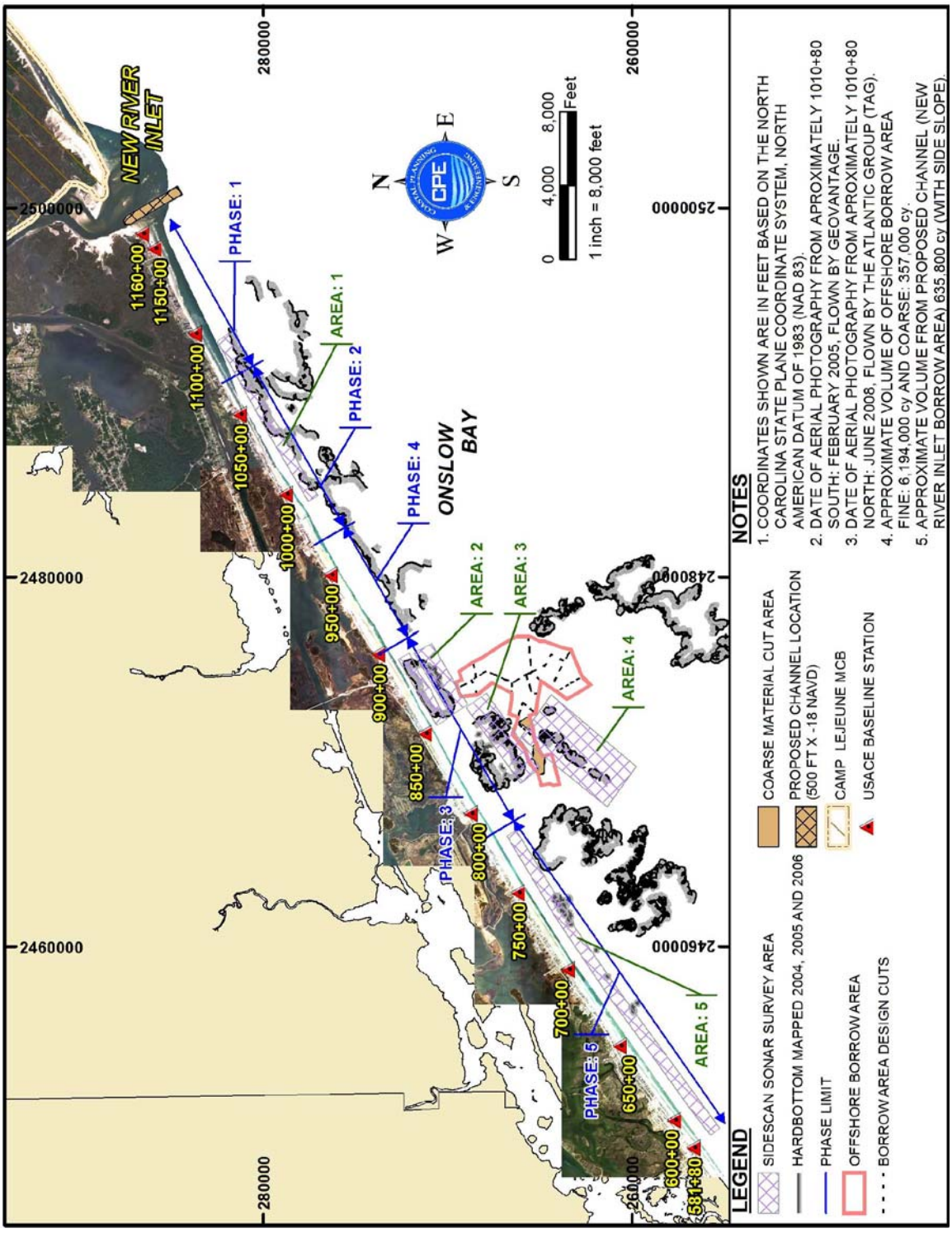

Figure 22. Geophysical Survey Areas

6.4.7.9 Sediment Monitoring

Sediment monitoring will be conducted during each construction phase that includes dredging of material from the offshore borrow area (Proposed Phases 2, 4, and 5). Sediment monitoring at the offshore transects will include 1) *in situ* sediment depth measurements and 2) line intercept documentation. *In situ* sedimentation monitoring will be conducted by divers, who will measure standing sediment (to nearest millimeter) at every meter along the permanent (50 m) transects. The line intercept method involves a trained diver to swim the length of the 50 m transect and note the locations along the transect where hardbottom and sand (depths >1 cm) intercept. The location of sediment patches greater than 0.5 m in length along the transect will be recorded. The results of the data collected will be used to determine the total sediment cover over each transect.

Sediment monitoring will be conducted along the 10 permanent offshore transects (TS – 9-14, 16-17, C – 3 and 5) (Figure 20). These offshore monitoring transects will be sampled for sedimentation once every two weeks for two months prior to construction (weather and sea state conditions permitting) and once every two weeks for the initial two months of construction. If sediment accumulation at the compliance transects is <10% of the sediment accumulated on average at the three control sites, then the sediment monitoring of the sites will occur once per month for the remainder of dredging operations. Within 30 days of project completion and demobilization of all contractor equipment from the project area, an immediate post-construction sediment monitoring event shall be conducted at the offshore monitoring sites.

6.4.7.10 Survey Vessel Navigation and Positioning

The navigation and positioning system deployed for all field operations, other than beach profiles, will be a Trimble Differential Global Positioning System (DGPS) interfaced to Hypack Inc.'s Hypack 2008® or similar system. A Pro Beacon receiver will provide differential GPS correction from the U.S. Coast Guard Navigational Beacon located at New Bern, NC. The DGPS initially receives the civilian signal from the global positioning system (GPS) NAVSTAR satellites. The locator automatically acquires and simultaneously tracks the NAVSTAR satellites, while receiving precisely measured code phase and Doppler phase shifts, which enables the receiver to compute the position and velocity of the vessel. The receiver then determines the time, latitude, longitude, height, and velocity once per second. Most of the time, the GPS accuracy with differential correction, provides for a position accuracy of one (1) to four (4) ft. This is within the accuracy needed for geotechnical investigations.

Navigational control will be maintained on a PC running Hypack 2008® software or similar system. The Hypack 2008® software is configured to acquire data from the differential GPS (DGPS) receiver system, and can be used to display the

survey plan superimposed on NOAA navigational charts, or project area graphics generated in GIS. The major advantage of this software is the capability of establishing track lines and specific targets for each of the sites prior to data collection. A computer monitor in the wheelhouse provides relative course correction information to the helmsman.

6.4.7.11 Beach Profile Surveys

During field investigations conducted by CPE in 2005 and 2006 it was established that visibility in the northern section of the project area would, at most times, prevent marine biologists from both characterizing the habitats and mapping the edge of the resources with any level of confidence. In order to provide an alternative method of verification, which would provide an acceptable level of confidence, the hardbottom monitoring plan will require the Town to collect beach profile data one (1) time along four (4) profiles between baseline stations 1080+00 and 1065+00 within 60 days prior to construction of Phase 1 and two (2) times post-construction of Phase 1. The first post-construction event would take place between 4 and 6 months post-construction and the second event between 16 and 18 months post-construction. Likewise the monitoring plan will require the Town to collect beach profile data along fourteen (14) profiles between USACE baseline stations 1075+00 and 1010+00 one (1) time prior to construction of Phase 2 and two (2) times post-construction of Phase 2 in the same time periods stated above. These beach profiles will be conducted in addition to sidescan sonar and ground truthing surveys in the vicinity of USACE baseline stations 990+00 to 1090+00 (Area 1) as shown in Figure 22.

Prior to the start of the beach profile survey, a reconnaissance of National Geodetic Survey (NGS) survey monuments will be conducted to confirm the survey control was in place and undisturbed. Real Time Kinematic (RTK) Global Positioning System (GPS) will be used to locate and confirm the survey control. In order to achieve required accuracy, the hydrographic survey will be controlled using known high accuracy NGS survey monuments.

Beach profiles will extend seaward to a depth greater than -30.0 ft. NAVD88. Soundings will be collected at minimal 25 ft. intervals, sufficient to provide an accurate depiction of the seafloor. Equipment to be employed for these surveys will include industry standard depth sounders, positioning equipment, and motion compensators. These beach profiles will provide vertical accuracy to within 0.2 - 0.5 ft., which is the International Hydrographic Organization standard.

Figures 23 and 24 show that hardbottom habitat is clearly visible in historic beach profile data. Likewise the particular hardbottom between USACE baseline stations 1010+00 and 1080+00 are evident by the 1.5 to 5 ft. scarps that are characteristic of many of the hardbottoms off the northern portion of North Topsail Beach (HDR, 2002 and Johnston, M.K., 1998). HDR (2002) reports that

these scarps border generally flat low lying hardbottoms. These findings support the concept of the perched beach, that is, the theoretical depth of closure would be seaward of the scarp; however, the vertical relief of the scarp precludes the further migration of sand offshore. Beach profile surveys may not resolve the migration of 0 to 5 inches of sand onto the hardbottom, covering it. However, beach profiles would show if these scarps features, which are clearly visible in previous beach profile (Figures 23 and 24), were not detected in subsequent beach profile data. By comparing pre and post-construction beach profiles, one will be able to determine if previously exposed hardbottom habitats have been covered based on the presence/absence of the scarp features that form the edges of these hardbottoms. Deliverables will include a brief report, survey report notes and charts, survey control information, and comparative profile plots. In addition, the report will clearly report the grain size of the fill that was placed along the surveyed profiles. These deliverables will be provided to the appropriate agencies.

As previously mentioned, sidescan sonar and groundtruthing surveys will be conducted at the same frequency as the beach profiles associated with nearshore hardbottom monitoring profiles in the northern section of the project area. The sidescan sonar mapping and beach profiles will provide a high level of confidence for monitoring project effects in the absence of BEAMR surveys.

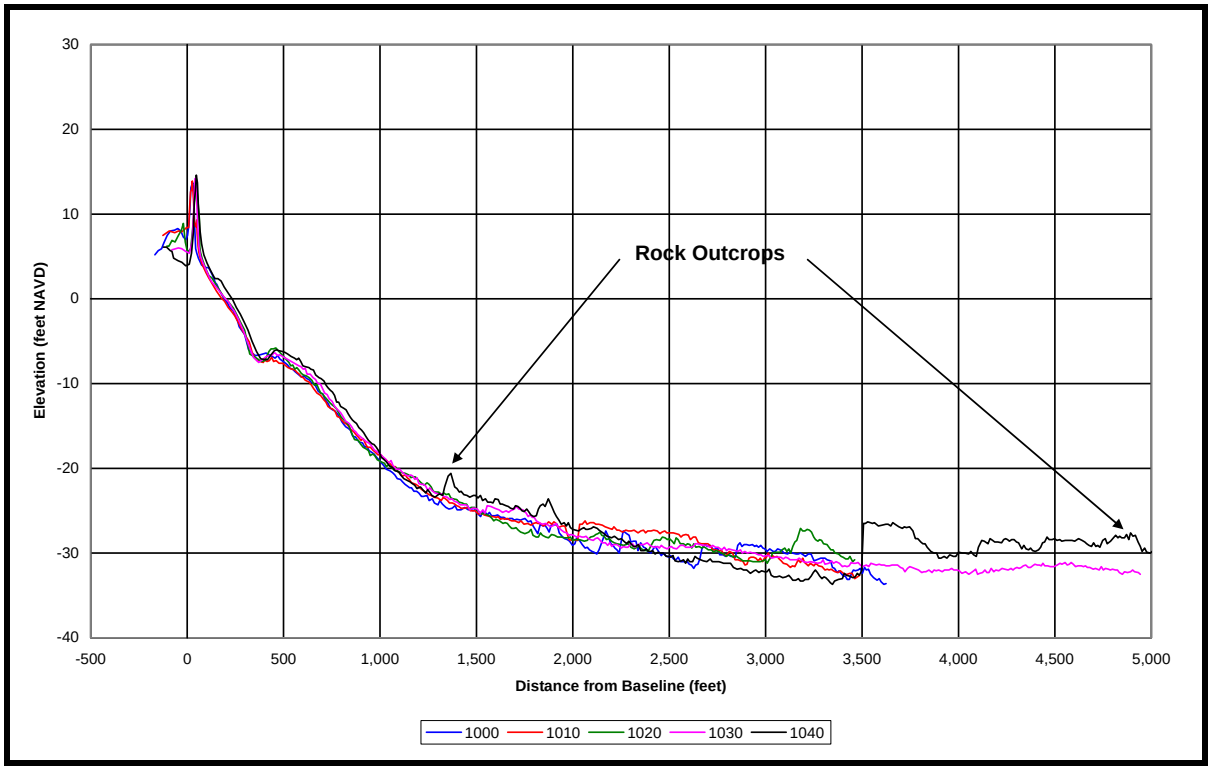

Figure 23. August 2005 beach profiles by CPENC, baseline stations 1000+00 to 1040+00.

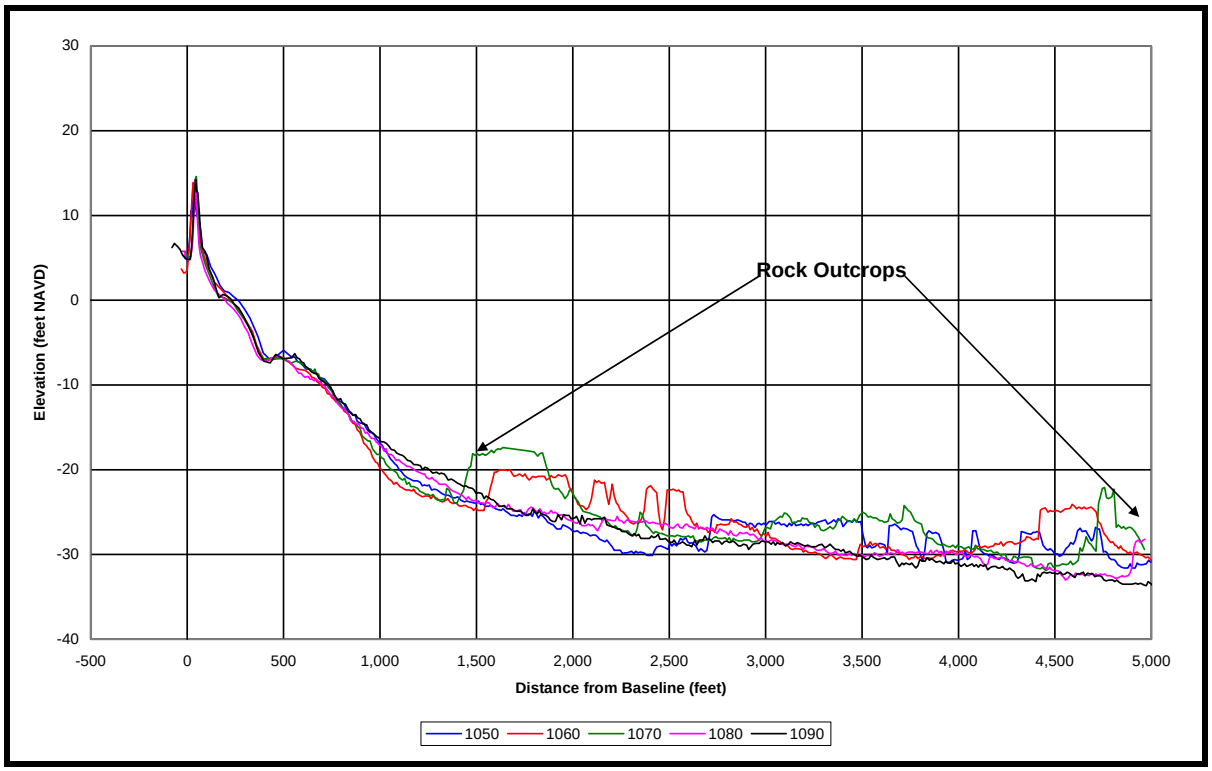

Figure 24. August 2005 beach profiles by CPENC, baseline stations 1050+00 to 1090+00.

6.4.7.12 Data Management and Reporting

One monitoring report shall be submitted 90 days after completion of the pre-construction monitoring event. Findings from the 2005 and 2006 investigations will be included in this report. A summary report detailing the sediment monitoring efforts from pre-construction and during construction will be submitted within 30 days of demobilization of all construction related equipment. In addition, a specific construction phase report describing any unanticipated mechanical impacts will be submitted to the USACE and NCDCM. Also included in this report detailing construction observations and unanticipated mechanical impacts will be the contractors as-built survey of the constructed beach fill.

A post-construction biological monitoring report will be submitted to the Town, USACE and NCDCM within 90 days after the post-construction monitoring event. The final report will present and discuss the results of the biological monitoring efforts and will include the results of the BEAMR statistical analysis of the nearshore and offshore transects during each monitoring event (pre-, mid and post-construction). An effect determination comparing pre-construction and post-construction conditions will also be presented in the report. Transect data collection and analysis will involve a quantitative analysis of the functional groups and a determination of any significant change in cover or abundance over the course of the study period. The reports will analyze and discuss project related

burial, sedimentation, or trauma that has affected the benthic communities based on the fixed station monitoring and transect line video documentation.

The reports will also include the following:

- Comparative analysis of hardbottom exposure within the study area including data (tabulated and graphical) and analysis of sediment thickness over each of the transects;
- A map of the monitoring area and adjacent hardbottom showing the location of fixed transects and quadrats with DGPS coordinates for the location of all major features;
- Quantitative data on major benthic biological components, e.g., percent cover by corals, octocorals, sponges, and algae;
- Statistical evaluation and comparison (paired or multiple) of the data collected along the permanent transects and monitoring stations to ascertain changes in community composition/abundance during the study period. If requested by the USACE or NCDCM, parametric and non-parametric (ANOVA) techniques may be used as appropriate to detect change in community composition/abundance.
- Copies of representative photographs and videos will be submitted in their original format; and
- A comprehensive environmental Project GIS database will be updated after each monitoring event.

A senior staff member independent of the Project will serve as the QA/QC Technical Reviewer to approve all pertinent deliverables before submission to the client, USACE and NCDCM.

No direct impacts by fill to hardbottom communities are anticipated. If it is determined, based on monitoring data, that impacts to adjacent hardbottom communities have occurred directly or indirectly from related construction activities then discussions will be initiated with the USACE and NCDCM to determine how to proceed.

6.4.8 Water Quality

The inlet, nearshore and offshore water columns are classified as SA and High Quality Water (HQW) under the North Carolina State water quality standards. This classification requires that work within the water column shall not cause turbidity levels to exceed 25 NTU or background (ambient) conditions that are above 25 NTU.

Dredge and fill operations are expected to temporarily elevate turbidity levels in the water column at the borrow area and fill sites. Higher turbidity levels are likely to be found in the discharge zone (nearshore swash zone) during periods of active construction. The use of a cutter suction dredge will minimize the area

of disturbance since this type of dredge involves suction for the extraction of sediment.

Turbidity monitoring during construction will be managed by the contractor. The contractor will be responsible for notifying the construction engineer in the event that turbidity levels exceed the State water quality standards.